ROYAL ASTRONOMICAL SOCIETY.

VOL. XVII. *April* 8, 1857. No. 6.

Rev. BADEN POWELL, V.P., in the Chair.

For Notice of a newly-discovered Planet, see page 169.

Volume XXV. of the *Memoirs* has recently been published. The price is 5*s*. to Fellows of the Society, and 10*s*. to the public. The sixteenth volume of the *Monthly Notices*, containing the shorter papers, abstracts of memoirs, and notices of discovery and new publications, is given to purchasers of the 4to. volume. The two publications are supplementary to each other, and are to be considered as parts of the same series. Between them they contain a complete account of the proceedings of the Society during the year.

The Editor wishes to call the attention of the usual contributors to the *Monthly Notices* to a few particulars in which they might materially lighten his labours without (it is hoped) imposing any troublesome constraint on themselves as writers of papers. At the present time numerous communications are sent without date, or signature, or any express intimation that they are intended for publication. The papers come to hand also of all sizes and shapes, rendering their arrangement, whether immediately for the press, or afterwards for preservation, difficult.

Diagrams, again, are often given either on too large a scale to serve as the copy for the engraver, or on too small a scale for him to be able to perceive what peculiarity he is to make clear. For instance, as when a circular arc is distorted slightly into a hyperbolic one; or when a shadow has some peculiarity of outline. Tables are also frequently sent so arranged as not to come within the limits of the page, when a very little ingenuity or an arrangement in three longer columns instead of four shorter ones, would save the necessity of copying them. The present Editor is no admirer of pedantic rules, or of requirements that signatures shall follow precisely at so many inches and tenths of an inch from the previous line; neither has he any wish to shift the ordinary and proper labour of editing on to the contributor; but a very little acquaintance with public correspondence, or with what is due to a learned Society, will, it is believed, make the following recommendations appear reasonable:—

1. That all papers intended for publication be dated, and headed "For the *Monthly Notices*," and that space be left above the body of the paper for Editor's heading.

2. That they be written in black ink, and on foolscap paper (13 × 8 inches), ruled with *about* three lines to the inch, with a margin of *about* an inch next the crease.

3. That papers in foreign languages, *when communicated through a resident Fellow*, be accompanied by an arranged translation.

4. That tables be arranged, as nearly as may be practicable, to suit the ordinary size of page; and that, when a diagram is required, one be given on a scale suited to the page, and a second (if required) on any larger scale, as large as may be necessary to elucidate the peculiarity to be represented.

5. That where optical or physical phenomena have been observed, the description of telescope, the aperture, focal length, ratio of aperture to focal length, and magnifying power, be stated in all cases.

A practicable degree of compliance with the above suggestions will, in addition to other advantages, lessen the time required for preparing and issuing successive numbers.

It has been already recommended that when regular and lengthened series of observations of planets or comets have been obtained, such series be sent for publication to Altona; but it is by no means intended to exclude from this periodical casual observations, moderate in number, or possessing immediate interest; as, for instance, the early observations of a newly-discovered body, occultations, or other phenomena.

From time to time Fellows of the Society send descriptions of new private observatories, not always accompanied or even followed by observations of value, and frequently insisting in the main on the lowness of the outlay, or the ease with which the

Observatory may be taken to pieces, as the motive for making the communication. Desirable as may be the increase in the number of such private establishments, each in its own locality fostering an interest in the branch of knowledge which this Society represents, it must be borne in mind that the only sufficient object of such a public statement is the enabling another person to judge of the relative sufficiency of the means used in procuring observations already published, or about to be published; and it will be at once perceived that such communications should be concise and to the point. Where some detail of construction is to be explained, an architect's plan and elevation with running notes is what is rather wanted, and will in that case be duly acknowledged, and deposited in the archives of the Society for the future consultation of any one about to build. Descriptions of a new eye-piece, a new material, or process of manufacture, a successful experiment or the like, do not, of course, come within the scope of the preceding remarks.

Results of the Observations of Small Planets made at the Royal Observatory, Greenwich, in the Month of March, 1857.

(*Communicated by the Astronomer Royal.*)

Parthenope.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
	h m s	° ′ ″
1857, Mar. 4	11 30 58·1	10 21 37·94	75 40 38·84
9	11 7 1·6	10 17 20·28	75 11 26·66
13	10 48 6·1	10 14 7·85	74 50 28·67
16	10 34 5·0	10 11 54·10	74 36 16·22
20	10 15 39·9	10 9 12·18	74 19 31·30

Fides.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
	h m s	° ′ ″
1857, Mar. 4	11 56 46·1	10 47 30·12	79 51 11·18
13	11 13 29·4	10 39 35·29	79 16 30·06
16	10 59 17·2	10 37 10·46	79 6 45·95
20	10 40 35·2	10 34 11·62	78 55 23·71
23	10 26 46·0	10 32 9·82	78 48 12·77

Hebe.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1857, Mar. 13 10 0 33·1	9 26 27·09	70 16 11·31
20 9 29 59·5	9 23 24·31	69 39 37·62
23 9 17 17·3	9 22 29·65	69 26 47·16

Psyche.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1857, Mar. 4 11 15 43·8	10 6 21·08	78 3 11·87
13 10 34 13·6	10 0 13·09	77 23 13·41
16 10 20 38·4	9 58 25·32	.....
20 10 2 45·8	9 56 15·95	76 57 23·17

Proserpine.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1857, Mar. 4 12 46 56·0	11 37 48·25	82 14 17·75
13 12 3 42·1	11 29 56·23	81 30 14·08
16 11 49 15·5	11 27 16·95	81 16 36·15

Iris.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1857, Mar. 20 14 3 23·0	13 57 32·69	109 2 40·90

*Mr. Pogson's New Planet.**

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1857, Apr. 17 11 44 15·4	13 28 25·77	105 30 7·58
18 11 39 20·2	13 27 26·32	105 23 11·07
20 11 29 30·7	13 25 28·32	105 9 4·24
23 11 14 49·3	13 22 34·20	105 47 19·04

* The observations of N.P.D. have *not* been corrected for parallax.

On a Variable Star. By the Astronomer Royal.

The Astronomer Royal desires to draw the attention of the Society to the star B.A.C. 3345, of which the variability seems to be very great. In the last year, 1856, several attempts were made to observe it, amongst other moon-culminating stars set down in the *Nautical Almanac* for 1859, but in every instance without success. In its stead, 19 *Leonis*, which precedes it by a few seconds of time, was observed four times; and a star which precedes 19 *Leonis* by ten seconds was observed twice, while nothing whatever was visible at the exact position of the star sought for. The observers reported the circumstance, and were directed to keep a vigorous watch for the missing star.

This year no difficulty has been found in observing it, four observations having been already made of it. On April 11 it was observed by Mr. Criswick, who remarks that it is the second of two stars visible in the field, and of a blood-red colour compared with the other star. Mr. Dunkin, who observed it on April 17, remarks that its colour was very red. These observers consider its magnitude at the times of observation to be the 7th.

The star is identical with Lalande 19197, who marks it as of the 9th magnitude. In Mayer's Catalogue, as revised by Mr. Baily (*Mem. R. A. S.* vol. iv.), it is No. 420.

It is also identical with Piazzi IX. 176, and is marked of the 8th magnitude. In Taylor's Madras Catalogue it is marked of the 7th magnitude. Finally, in Argelander's *Uranometria Nova* it is called variable.

The statement here given will, it is hoped, induce astronomers to watch the star during the present season, before it approaches too closely to conjunction with the sun.

Discovery of another Small Planet.

Another member, the forty-third, of the group of small planets circulating between *Mars* and *Jupiter*, was discovered at Oxford on the 15th of April by Mr. Norman Pogson, in comparing with the heavens one of his MSS. charts. The following are Mr. Pogson's first observations,—

1857.	G.M.T.	App. R.A.	App. N.P.D.
	h m s	h m s	° ′ ″
April 15	13 34 14	13 30 19·96	105 43 2·5
	13 57 12	30 18·98	42 56·7
	15 24 31	30 15·26	42 36·3

Intelligence was circulated throughout the country on the two following days; and observations from Greenwich, Cambridge, and

Liverpool, will be found in the present Number. So far as we have heard at present, Mr. Pogson has no one to share his honours with him on the present occasion.

Observations.

LIVERPOOL. Equatorial. (Mr. Hartnup.)

1857.	G.M.T.	R.A.	Log $\frac{p}{P}$	N.P.D.	Log $\frac{q}{P}$
	h m s	h m s		° ′ ″	
April 18	9 54 35·7	13 27 30·64	−8·305	105 23 40·7	−9·9584
	10 14 32·4	29·79	−8·230	34·9	−9·9614
	10 34 28·9	28·98	−8·134	30·0	−9·9638
19	9 46 40·3	13 26 31·63	−8·315	105 16 43·4	−9·9577
	9 58 38·3	31·23	−8·273	39·6	−9·9596
	10 10 36·2	30·75	−8·225	36·1	−9·9613
20	9 41 45·5	13 25 32·69	−8·315	105 9 38·3	−9·9574
	9 53 43·3	32·21	−8·273	35·6	−9·9592
	10 5 41·2	31·82	−8·225	30·4	−9·9610

The observations are corrected for refraction.

The following is the assumed mean place of the Star of Comparison for Jan. 0·1857, deduced from the Greenwich and Edinburgh Observations :—

B. A. C. 4494. R.A. $13^h\ 19^m\ 49^s{\cdot}78$. N.P.D. $105°\ 13'\ 51''{\cdot}64$.

CAMBRIDGE. Equatorial. (Prof. Challis.)

1857.	G.M.T.	R.A.	$p \times \Delta$	N.P.D.	$q \times \Delta$	No. of Comp.	Star.
	h m s	h m s	s	° ′ ″	″		
April 17	10 37 31·6	13 28 29·26	−0·104	105 30 5·4	−7·85	8	*q*
18	10 25 34·9	13 27 30·04	−0·115	105 23 14·8	−7·83	8	*q*

The star (*q*) is H.C. 25079 and 25080, and its assumed mean place 1857·0 is R.A. = $13^h\ 26^m\ 59^s{\cdot}93$, N.P.D. = $105°\ 35'\ 9''{\cdot}6$ as given by the Catalogue.

Observations of Comet I., 1857 (D'Arrest's).

CAMBRIDGE. Equatorial. (Prof. Challis.)

1857.	G.M.T.	R.A.	$p \times \Delta$	N.P.D.	$q \times \Delta$	No. of Comp.	Star.
	h m s	h m s	s	° ′ ″	″		
March 4	16 43 34·1	22 1 0·09	−0·404	59 34 50·2	−6·12	8	*a*
28	8 13 40·5	1 43 18·20	+0·495	43 28 28·2	5·56	5	*b*
April 2	8 58 20·6	2 48 32·61	0·478	45 24 32·9	5·68	12	*c*
15	9 30 59·0	4 47 42·57	0·414	57 35 13·9	5·94	6	*d*
16	8 52 32·7	4 54 14·45	+0·410	58 34 59·0	−5·50	6	*e*

Assumed Apparent Places of the Stars.

	Apparent R.A.	Apparent N.P.D.	Authority.
	h m s	° ′ ″	h m s
a	21 59 48·39	59 34 41·4	Bessel Z. 327, 21 58 15
b	1 42 9·24	43 19 23·9	Argelander 2051
c	2 44 21·26	45 27 19·3	H.C. 5364
d	4 46 14·78	57 27 7·5	H.C. 9171
e	4 53 4·04	58 26 0·0	H.C. 9389

Passage of D'Arrest's Comet over a Fixed Star. Observed by R. Hodgson, Esq.

"At about 10^h mean time on the 3d of April, the comet of D'Arrest passed over a small star. Its appulse was not noticed, the telescope having been turned to another object; but upon returning to the comet, the small star was missed, and with power of 70 was not divisible from the nucleus. On changing to power 140, the small star was instantly visible, about midway between the nucleus and edge of the comet, *above* the centre (as seen in an inverting telescope). The star was of 7th magnitude, and was decidedly much brighter than the nucleus of the comet."

We learn through Dr. Gould's *Astronomical Journal* that the comet of Professor D'Arrest was also discovered independently at Newark in the United States, by Mr. Van Arsdale.

Observations of Comet II., 1857 (*Bruhns's*).

CAMBRIDGE. Equatorial. (Prof. Challis.)

1857.	G.M.T.	R.A.	$p \times \Delta$	N.P.D.	$q \times \Delta$	No. of Comp.	Star.
	h m s	h m s	s	° ′ ″	″		
March 23	8 9 34·3	2 20 50·43	+0·361	76 29 43·9	−6·53	1	*f*
April 7	8 47 37·0	3 17 38·15	0·405	58 53 14·9	6·19	14	*g*
8	9 16 36·6	3 21 54·89	0·399	57 36 38·7	6·47	10	*h*
9	8 21 5·1	3 26 4·44	0·421	56 24 13·8	5·72	8	*i*
11	8 43 53·9	3 35 6·52	0·431	.....	...	9	*k*
11	8 53 47·9	.....	...	53 50 58·8	5·98	2	*k*
15	8 49 51·7	3 54 49·80	0·462	48 47 28·6	5·55	6	*l*
16	8 24 13·2	4 0 7·96	0·475	47 33 19·0	5·04	6	*m*
17	8 33 31·9	4 5 45·94	0·485	46 17 24·0	5·07	8	*n*
18	8 22 20·8	4 11 33·84	0·496	45 3 22·2	4·75	7	*o*
20	8 36 6·0	4 24 5·53	+0·518	42 35 51·5	−4·70	8	*p*

Assumed Apparent Places of the Stars.

	Apparent R.A.	Apparent N.P.D.	Authority.
	h m s	° ′ ″	
f	2 23 8·40	76 40 41·1	Bessel II. 383
g	3 16 33·92	58 46 27·9	H.C. 6265
h	3 19 14·62	57 41 16·4	H.C. 6344
i	3 27 41·68	56 7 32·8	H.C. 6597
k	3 35 14·89	53 59 31·3	H.C. 6820
l	3 58 31·69	48 53 36·7	H.C. 7584
m	3 58 17·04	47 11 31·2	H.C. 7568 and 7569
n	4 7 59·71	46 40 7·2	H.C. 7915
o	4 10 38·80	44 52 40·8	H.C. 8015
p	4 25 41·91	42 56 26·6	H.C. 8553 and 8554

LIVERPOOL. Equatorial. (Mr. Hartnup.)

1857.	G.M.T.	R.A.	Log $\frac{p}{P}$	N.P.D.	Log $\frac{q}{P}$	Star.
	h m s	h m s		° ′ ″		
April 7	8 25 25·6	3 17 33·51	+8·668	58 54 20·5	−9·8352	(*a*)
	8 52 26·7	3 17 37·99	+8·665	58 53 2·8	−9·8577	
11	8 45 10·8	3 35 7·29	+8·693	53 51 33·8	−9·8279	(*b*)
	9 10 12·3	3 35 12·21	+8·685	53 50 15·1	−9·8536	
14	8 22 52·8	3 49 33·95	+8·715	50 4 54·9	−9·7790	(*c*)
	8 47 54·2	3 49 39·15	+8·715	50 3 37·1	−9·8079	
16	8 25 32·2	4 0 7·76	+8·732	47 33 29·4	−9·7616	(*d*)
	8 45 33·7	4 0 11·78	+8·732	47 32 23·9	−9·7870	

The observations are corrected for refraction. The corrections to be applied for parallax in time, and are represented by p and q. P is the equatorial horizontal parallax.

The following are the assumed mean places of the Stars of Comparison for 1857·0:—

Star.	R.A.	N.P.D.	Authority.
	h m s	° ′ ″	
(*a*) = B. A. C. 1138	3 35 21·61	58 10 6·21	Greenwich Observations.
(*b*) = ,, 1219	3 48 16·03	50 24 26·70	,, ,,
(*c*) = ,, 1291	4 5 9·91	49 53 1·75	British Association Cat.
(*d*) = ,, 1339	4 13 39·13	47 54 40·19	,, ,,

From the 7th to the 16th no perceptible difference was observed in the appearance of the comet. The nebulosity was round, and of about 1′ 40″ diameter. For about 15″ from the centre it was very bright.

Any doubt that might have been supposed to remain on the identity of the comet discovered by Dr. Bruhns with that of Brorsen in the year 1846, has been removed by an investigation by Dr. Bruhns, which has appeared recently in the *Astron. Nach.* Dr. Bruhns's Elements are given on the next page with the portion of his Ephemeris which is still available.

T = March 29^d·25384 Berlin M.T.

π = 115° 48′ 37″·0
Ω = 101 53 7·9 } App. Eq. March 20·0
i = 29 45 0·8
φ = 53 17 0·7
Log a = 0·494912

Ephemeris for Berlin Midnight.

1857.	R.A.	N.P.D.	1857.	R.A.	N.P.D.
	h m s	° ′		h m s	° ′
May 1	6 3 8	30 43·8	May 17	9 47 14	28 48·0
2	15 12	29 56·9	18	59 30	29 25·1
3	27 51	29 14·3	19	10 11 11	30 5·7
4	41 3	28 36·2	20	22 16	30 49·4
5	6 54 45	28 3·3	21	32 46	31 36·1
6	7 8 53	27 35·5	22	42 42	32 25·1
7	23 24	27 13·3	23	10 52 5	33 16·4
8	38 13	26 56·9	24	11 0 58	34 9·4
9	7 53 13	26 46·6	25	9 21	35 3·8
10	8 8 17	26 42·2	26	17 14	35 59·3
11	23 18	26 43·6	27	24 40	36 56·0
12	38 10	26 50·8	28	31 40	37 53·5
13	8 52 48	27 4·0	29	38 18	38 51·6
14	9 7 4	27 22·6	30	44 35	39 50·1
15	20 57	27 46·2	31	50 33	40 48·6
16	9 34 22	28 14·9	June 1	11 56 14	41 46·8

Relative brightness, that at the time of discovery being taken for unity:—

April 6	...	1·70	May 12	...	1·01
18	...	1·72	24	...	0·70
30	...	1·45	June 1	...	0·50

From Letters of Captain Jacob to Mr. Grant.

"Feb. 13.—I have got a very good epoch for α *Centauri* for the beginning of this year, namely—

Year.	$\angle$	δ
	°	″
1857·039	316·96	3·977

being the mean result of 15 days' observations. This is as close an accordance as could be expected with the predicted place as

given in page 124 of the *Monthly Notice* for March 1856, and indicates a path even more *convex* toward the centre than is there indicated. I have had some very fine views of *Saturn* lately; and I have been pretty assiduously observing the satellites (especially elongations of *Titan*) to try if I can improve the value of *Saturn's* mass: and I have numerous observations of *all* the other satellites except *Hyperion*, which I have not yet picked up. I have even six undoubted observations of *Mimas*. It was picked up quite accidentally, for I never thought of looking for it after reading Herschel's Cape experience, and after the difficulty I had myself found with *Enceladus;* but I took it once in the first instance by mistake for *Enceladus*, and afterwards picked it up without difficulty; indeed on a first-rate night, such as we get but rarely even here, it appears rather the brighter of the two. Such a night was the 21st January, when I got measures of *Enceladus* close to *Saturn's* pole, and when I saw the whole of the shaded portion of *Saturn's* southern hemisphere divided into minute belts almost as distinct as those of *Jupiter*, but almost infinitely more numerous. I can fully confirm the opinion expressed by Mr. John Watson in the *Monthly Notice* for April last as to the nature of the mark on the outer ring, viz., that it is not a *division*, but a mere belt or streak: it is not at all difficult to see here, indeed I cannot look at *Saturn*, when the atmosphere is at all fit for observing, without seeing it, even with powers as low as 170; it appears as a pale streak, about one-third or rather more of the width of the principal division, and not quite so dark in hue as the obscure ring as seen on the planet's face. But further, it is *my* opinion that the principal *division*, so called, is of the same character, viz., a belt or mark, and not a clear space or division; for I not only see it of a brown hue, but *can distinctly make out the shadow of the planet across it*, as already mentioned at page 126 of the *M. Not.* for March 1856. On the 1st January, when the planet was almost exactly in opposition, the projecting *ears* alluded to in the same page were seen one on each side, crossing the division, though no other part of the planet's shadow on the ring was visible."

"Feb. 28.—I have nearly completed my measures of the satellites for this season, and they ought to give a good value of the planet's mass, as I have good distance-measures of *Titan* at 10 elongations (5 E and 5 W); and also a large number of pretty good measures, both in angle and distance, of all the five *old* satellites, on which it may perhaps be possible to build a *theory*, and to approximate at least to the mass of the ring. As I have not access to Bessel's Observations, I do not know how far he may have anticipated me in these respects; but there will be no harm done even if my results should merely come in as corroborative of his."

Observatory, Madras.

Observations of the Satellites of Uranus. By W. Lassell, Esq.

		Ariel.	Umb.	Titania.			Oberon.		
1856.	G.M.T.	Position (Estimated).	Position (Estimated).	G.M.T.	Position.	Distance.	G.M.T.	Position.	Distance.
	h m	°	°	h m	° ′		h m	° ′	
Nov. 6	11 40	180	335	12 10	41 13		11 52	271 41	
				12 39·5		28·69	12 28·5		37·83
28	10 5	249	215		212	(all estimations)		55	
29	11 15	160	80	11 27	175 36				
				12 48		32·70	12 17·8		42·37
30	10 15	328	50				11 7·0	351 34	
							10 33·0		43·40
Dec. 1	10 25	180		10 33·9	93 31		10 45·9	327 52	
				11 7·2		29·45	11 20·0		41·80
14	10 45	185	280	11 1·0	272 19		11 12·5	339 3	
				11 43·4		29·44	11 29·3		42·66
18	9 50	280	295	10 9·1	112 47		10 25·1	228 5	
				10 43·3		26·91	11 2·3		40·27
26	10 0	210		10 9·9	141 40		10 19·3	17 41	
				10 41·4		30·44	10 30·9		41·79
27	10 2	80	225	10 47·0	96 19		10 57·0	350 44	
				10 35·0		28·30	10 12·4		42·64
28				10 47·5	55 45		10 57·7	326 56	
1857.				10 26·2		29·08	10 3·1		41·35
Jan. 13							9 17·0	76 29	
							9 6·0		37·13

REMARKS.

Nov. 6. The sky gradually became hazy, and the measures of distance were taken with extreme difficulty.

Nov. 28. *Umbriel*, which is generally the faintest of the satellites, was not seen without patient attention for some time. The sky became cloudy before measures of any of the satellites could be procured.

Nov. 29. Vision very diffused and the planet moulding and ill-defined.

Nov. 30. There was a star in magnitude between the brightness of the faintest two satellites and *Titania*, and almost in the path of the latter, so that I was some time in ascertaining its nature. This is a very rare occurrence.

Dec. 14. Taking into account the bright moonlight, *Ariel* and *Umbriel* were remarkably well shown. I don't think the intrinsic brightness of *Ariel* is very inferior to that of *Titania*, but its proximity to the planet renders

it far more difficult to see For this reason I have never been able to obtain in England satisfactory measures of distance of these inner satellites.

Dec. 18. Definition very bad and measures most difficult to take.

The instrument used was the 20-feet Equatorial with a magnifying power, generally, of 614.

Bradstones, near Liverpool, 4th April, 1857.

Erratum.—In the *Monthly Notices*, vol. xiii. p. 149, the position of *Oberon*, Nov. 2, instead of 206° 40′ should be 196° 40′. This error was discovered by Dr. Marth, who, in discussing these observations found this measure to stand out greatly from the series; and on reference to my MSS., I find it occurred in an erroneous addition in deducing the angle from the north point from the angle with the parallel.

Note to the Paper on Optical Phenomena in Occultations in the preceding Number. By Professor Powell.

"In my remarks on the observations, I put a suggestion whether the appearance observed by Prof. Challis might not have been a projection. I have since received a letter from that gentleman, in which he states, 'The depression which I noticed at the part of moon's limb when *Jupiter* reappeared was an actual inequality of the limb, and was as conspicuous before and after, as during the occultation.'

"He further observes that what he saw agrees well with Mr. Hartnup's description (*Monthly Notices*, vol. xvii. p. 73). He also saw the second satellite, at its reappearance, bisected by the moon's limb just at the extremity of the same depression.

"I am anxious to take the earliest opportunity of correcting any misapprehension on this point."

On the Correction of Sextant-Observations. By W. H. Simms, Esq.

In two papers recently laid before the Royal Astronomical Society I have discussed in detail the errors to which the several parts of the sextant are liable, and the effects of these errors upon observations made with that instrument. But as in the said papers the subject has been treated at some length, and as practical men, scientific explorers and navigators, who are in the habit of using the sextant, will be glad to have it placed before them in a simple and practical form, I omit on this occasion everything of the nature of investigation, confining myself to formulæ and examples, a careful consideration of which will enable any person tolerably well versed in the manipulation of tables to correct his observations, and thus to obtain results upon which he may rely to a much greater extent than he could upon such as he might obtain

from the simple readings corrected only for index-error in the ordinary way.

The principal error for which correction is required is that of eccentricity; an error from which few sextants are exempt, and which affects unequally the angles read from different points of the limb, the maximum effect being seldom less than thirty seconds, sometimes exceeding two minutes. The formula for correction reduced to its most simple form, and including the effect of index-error is

$$\Omega = \omega + \varepsilon + \tfrac{1}{2} k \,.\, \sin\{v + \tfrac{1}{2}(\omega)\}^*$$

where ω is the reading made in the ordinary way; (ω) the degrees and minutes on the arc at the point of coincidence of divisions; ε, k, v, constants; and Ω the corrected angle. By means of this formula, the values of the constants being known, any reading may be corrected; or we may form a table of corrections for every 5 or 10 degrees of the arc, and thence take the particular correction required on each several occasion.

To find the values of the constants, three known angles must be observed, one near to each extremity, the third near the middle of the arc. Let the known values of these angles be, in order of magnitude, Ω_1, Ω_2, Ω_3; and let ω_1, ω_2, ω_3, be the uncorrected readings from the limb of the sextant; (ω_1), (ω_2), (ω_3), the degrees and minutes on the limb at the points of coincidence of divisions. Compute

$$c_1 = \Omega_2 - \Omega_1 - (\omega_2 - \omega_1) \qquad c_2 = \Omega_3 - \Omega_1 - (\omega_3 - \omega_1)$$

$$\theta_1 = \tfrac{1}{4}\{(\omega_2) - (\omega_1)\}; \qquad \theta_1' = \tfrac{1}{4}\{(\omega_2) + (\omega_1)\};$$

$$\theta_2 = \tfrac{1}{4}\{(\omega_3) - (\omega_1)\}; \qquad \theta_2' = \tfrac{1}{4}\{(\omega_3) + (\omega_1)\}$$

$$\tan v = \frac{c_1 \,.\, \sin\theta_2 \,.\, \cos\theta_2' - c_2 \,.\, \sin\theta_1 \,.\, \cos\theta_1'}{c_1 \,.\, \sin\theta_2 \,.\, \sin\theta_2' - c_2 \,.\, \sin\theta_1 \,.\, \sin\theta_1'};$$

$$k = \frac{c_1}{\sin\theta_1 \,.\, \cos(v + \theta_1')};$$

$$\varepsilon = \Omega_1 - \omega_1 - \tfrac{1}{2} \,.\, k \,.\, \sin\{v + \tfrac{1}{2}(\omega_1)\}$$

whence the constants are determined.

We may now for every 5° or 10° of (ω) compute and tabulate the values of $\frac{1}{2} k \,.\, \sin\{v + \frac{1}{2}(\omega)\}$; and the process of correcting any angle ω will then consist in the application, first of ε, then of the value of $\frac{1}{2} k \,.\, \sin\{v + \frac{1}{2}(\omega)\}$ standing opposite to (ω) in the table.

It is necessary only that the index-error should not change in the course of the observations from which we derive the values of the constants; but it may vary afterwards, and as a variation in this will produce one in the value of ε, we shall have to determine ε from time to time in the following manner:—

Let ω, ω' be the two readings which correspond to opposite contact of the sun's limb; (ω), (ω'), the degrees and minutes at

* v is the angle ZOY, and ε the quantity $\omega' - \frac{1}{2} \,.\, k \,.\, \sin \mathrm{ZOA}'$ of the investigation contained in the second of the papers laid before the Society.

coincidence of divisions. Then, $2r$ being the sun's apparent diameter,

$$2r = \omega + \varepsilon + \text{quantity opposite } (\omega) \text{ in the Table}$$
$$-2r = \omega' + \varepsilon + \text{quantity opposite } (\omega') \text{ in the Table}$$

and therefore $\varepsilon = -\frac{1}{2}(\omega + \omega') - \frac{1}{2}$ sum of quantities opposite (ω) and (ω') in the table.

With respect to the three known angles to be observed for the determination of the constants; of these, the first may be either the sun's apparent diameter, or actual coincidence of the two images of a star, in which latter case the angle will be 0. The second and third should be distances of well-known stars from one another, these distances being computed for the occasion, or circum-meridian altitudes at a place of which the latitude is known. Each observation should of course be repeated several times.

To compute the apparent distance between two stars, we have the following formula:—

Let π_1, A_1 be the true polar distance and right ascension of the first star; π_2, A_2 of the second;

ζ_1, ζ_1' the apparent and true zenith distance of the first; ζ_2, ζ_2' of the second;

the polar distances and right ascensions being taken from the tables; and the zenith distances either computed, or derived from altitudes observed in the course of the observations of distance.

Compute

$$\log\tan\theta = \tfrac{1}{2}\{\log\sin\pi_1 + \log\sin\pi_2 + \log\sin\tfrac{1}{2}(A_1 \sim A_2)\} - \log\sin\tfrac{1}{2}(\pi_1 \sim \pi_2);$$
$$\log\sin\tfrac{1}{2}D = \log\sin\tfrac{1}{2}(\pi_1 \sim \pi_2) - \log\cos\theta;$$
$$\beta = \tfrac{1}{2}(\zeta_1' + \zeta_2' + D)$$
$$\log\sin\psi = \tfrac{1}{2}\{\log\sin\beta + \log\sin(\beta - D) + \log\sin\zeta_1 + \log\sin\zeta_2 - (\log\sin\zeta_1' + \log\sin\zeta_2')\} - \log\sin\tfrac{1}{2}(\zeta_1 + \zeta_2)$$

Then, D′ being the apparent distance required,

$$\log\sin\tfrac{1}{2}D' = \log\sin\tfrac{1}{2}(\zeta_1 + \zeta_2) + \log\cos\psi.$$

The following is an example of the process:—

Suppose that on the 1st of March, 1857, in latitude 51° 30′ N., and the longitude of Greenwich, the observations were

1. Mean of ten readings for contact of sun's limb = + 30′ 11″; the sun's apparent altitude being 30°, and the Bar. 30^{in}·00, Ther. 54°.

2. At 6½^h mean time. Mean of ten observed distances between *Capella* and *α Orionis* = 39° 27′ 5″.

3. At 7^h mean time. Mean of ten observed distances between *α Ursæ Majoris* and *Sirius* = 93° 17′ 23″.

The barometer and thermometer for observations 2 and 3 being 29^{in}·95 and 40°.

On the 1st of March the sun's true diameter = 32′ 20″; and the difference of refraction for 32′ at altitude 30° is 1″. The

apparent vertical diameter therefore = 32′ 19″; and the first observation gives

$$\Omega_1 = 32' 19''; \quad \omega_1 = 30' 11''; \quad (\omega_1) = 0° 41'.*$$

Next to compute the apparent distance between *α Orionis* and *Capella* at $6\frac{1}{2}^h$ P.M.

	h m s		° ′ ″
A_1	= 5 47 26·64	ϖ_1	= 82 37 21
A_2	= 5 6 8·53	ϖ_2	= 44 8 52
$\frac{1}{2}(A_1 - A_2)$	= 20 39·06	$\frac{1}{2}(\varpi_1 - \varpi_2)$	= 19 14 15
or	= 5° 9′ 46″		

The altitudes were not observed. We must therefore compute the zenith-distances from the formulæ,

$$\log \tan \chi = \log \tan \phi + \log \cos H;$$
$$\log \cos \zeta' = \log \cos \phi - \log \cos \chi + \log \cos (\varpi - \chi);$$

where ϕ is the colatitude of the place, and H the hour-angle of the star from the meridian.

Log tan ϕ	= 9·9006052	Log cos ϕ	= 9·8935444
Log cos H_1	= 9·9935398	Log cos χ	= 9·8960247
Log tan χ	= 9·8941450	Diff.	= 9·9975197
χ	= 38° 5′ 8″	Log cos $(\varpi_1 - \chi)$	= 9·8529667
ϖ_1	= 82 37 21	Log cos ζ_1'	= 9·8504864
$\varpi_1 - \chi$	= 44 32 13	ζ_1'	= 44° 52 ′3″
		Refraction	= − 0 59
		ζ_1	= 44 51 4

Similarly we shall obtain $\zeta_2' = 5° 39' 19''$, $\zeta_2 = 5° 39' 13''$.

Log sin ϖ_1	= 9·9963898	Log sin $\frac{1}{2}(\varpi_1 - \varpi_2)$	= 9·5178352
Log sin ϖ_2	= 9·8429282	Log cos θ	= 9·9890911
Sum	= 9·8393180	Log sin $\frac{1}{2}$ D	= 9·5287441
Half	= 9·9196590	$\frac{1}{2}$ D	= 19° 44′ 49″
Log sin $\frac{1}{2}(A_1 - A_2)$	= 8·9541729		
Sum	= 8·8738319	D	= 39 29 38
Log sin $\frac{1}{2}(\varpi_1 - \varpi_2)$	= 9·5178352	$\therefore$ β	= 45 0 30
Log tan θ	= 9·3559967	β − D	= 5 30 52

* This may be either taken from the arc at the time of reading, or derived subsequently by adding to the degrees of ω the number of minutes taken from the vernier, and to the minutes of ω taken from the arc the number of seconds taken from the vernier.

Log sin β	$= 9{\cdot}8495482$	Log sin ζ_1'	$= 9{\cdot}8484783$
Log sin $(\beta - D)$	$= 8{\cdot}9827084$	Log sin ζ_2'	$= 8{\cdot}9936259$
Log sin ζ_1	$= 9{\cdot}8483535$	K	$= 8{\cdot}8421042$
Log sin ζ_2	$= 8{\cdot}9934983$		
Sum	$= 7{\cdot}6741084$	Log sin $\frac{1}{2}(\zeta_1 + \zeta_2)$	$= 9{\cdot}6300292$
K	$= 8{\cdot}8421042$	Log cos ψ	$= 9{\cdot}8985635$
Diff.	$= 8{\cdot}8320042$	Log sin $\frac{1}{2}$ D′	$= 9{\cdot}5285927$
Half	$= 9{\cdot}4160021$		
Log sin $\frac{1}{2}(\zeta_1 + \zeta_2)$	$= 9{\cdot}6300292$	$\frac{1}{2}$ D′	$= 19^\circ\ 44'\ 23''$
Log sin ψ	$= 9{\cdot}7859729$	D′	$= 39\ 28\ 46$

Hence the second observation gives

$$\Omega_2 = 39^\circ\ 28'\ 46''; \quad \omega_2 = 39^\circ\ 27'\ 5''; \quad (\omega_2) = 46^\circ\ 25'.$$

Similarly from the third we derive

$$\Omega_3 = 93^\circ\ 18'\ 43''; \quad \omega_3 = 93^\circ\ 17'\ 23''; \quad (\omega_3) = 100^\circ\ 33'.$$

Hence,

$$\Omega_2 - \Omega_1 = 38^\circ\ 56'\ 27''; \quad \omega_2 - \omega_1 = 38^\circ\ 56'\ 54''; \quad c_1 = -27'';$$
$$\Omega_3 - \Omega_1 = 92\ 46\ 24; \quad \omega_3 - \omega_1 = 92\ 47\ 12; \quad c_2 = -48;$$

$$(\omega_2) - (\omega_1) = 45^\circ\ 44'; \quad (\omega_2) + (\omega_1) = 47^\circ\ 6'; \quad \theta_1 = 11^\circ\ 26'; \quad \theta_1' = 11^\circ\ 47';$$
$$(\omega_3) - (\omega_1) = 99\ 52; \quad (\omega_3) + (\omega_1) = 101\ 14; \quad \theta_2 = 24\ 58; \quad \theta_2' = 25\ 19.$$

Log $-c_1$	$= 1{\cdot}43136$	Log $-c_1$	$= 1{\cdot}43136$
Log sin θ_2	$= 9{\cdot}62541$	Log sin θ_2	$= 9{\cdot}62541$
Log cos θ_2'	$= 9{\cdot}95615$	Log sin θ_2'	$= 9{\cdot}63106$
Sum	$= 1{\cdot}01292$	Sum	$= 0{\cdot}68783$
Nat. No.	$10{\cdot}302$	Nat. No.	$4{\cdot}873$

Log $-c_2$	$= 1{\cdot}68124$	Log $-c_2$	$= 1{\cdot}68124$
Log sin θ_1	$= 9{\cdot}29716$	Log sin θ_1	$= 9{\cdot}29716$
Log cos θ_1'	$= 9{\cdot}99075$	Log sin θ_1'	$= 9{\cdot}31008$
Sum	$= 0{\cdot}96915$	Sum	$= 0{\cdot}28848$
Nat. No.	$9{\cdot}314$	Nat. No.	$1{\cdot}943$

Whence,

$$\tan v = \frac{-10{\cdot}302 + 9{\cdot}314}{-4{\cdot}873 + 1{\cdot}943} = \frac{0{\cdot}988}{2{\cdot}930}. \quad \text{Log tan } v = 9{\cdot}52789;$$
$$v = 18^\circ\ 38': \quad v + \theta_1' = 30^\circ\ 25': \quad v + \tfrac{1}{2}(\omega_1) = 19^\circ\ 0'.$$

Log cos $(v + \theta_1')$	= 9·93569
Log sin θ_1	= 9·29716
Sum	= 9·23285
Log $- c_1$	= 1·43136
Log $- k$	= 2·19851
Log sin $\{v + \frac{1}{2}(\omega_1)\}$	= 9·51264
	1·71115 = Log 51″·4

Therefore $\varepsilon = 2' 8'' + 25''{\cdot}7 = + 2' 33''{\cdot}7$; and the general equation is

$$\Omega = \omega + 2' 33''{\cdot}7 - 78''{\cdot}97 \cdot \sin\{18° 38' + \tfrac{1}{2}(\omega)\}.$$

We now compute the following table of the values of

$$\tfrac{1}{2} k \cdot \sin\{v + \tfrac{1}{2}(\omega)\}:$$

(ω)		(ω)		(ω)	
°	″	°	″	°	″
0	−25·2	35	−46·6	70	−63·6
5	28·5	40	49·3	75	65·6
10	31·7	45	51·9	80	67·4
15	34·8	50	54·5	85	69·2
20	37·8	55	56·9	90	70·8
25	40·8	60	59·3	95	72·2
30	43·7	65	61·5	100	73·5

and we are thus furnished with all we require for the correction of angles.

Suppose, for example, it were required to correct the angle 39° 27′ 5″ read from the limb of the sextant. Here,

$$\omega = 39° 27' 5'', \quad (\omega) = 39° 20' + 7° 5' = 46° 25'$$

and the corrected angle,

$$= 39° 27' 5'' + 2' 33''{\cdot}7 - 52''{\cdot}9 = 39° 28' 45''{\cdot}8.$$

A table similar to the above will continue to answer during a long period for the instrument for which it was obtained, the values of the constants k and v not being liable to disturbance except in consequence of serious accident or the operations of the maker in the course of repair. The constant ε is however liable to occasional disturbance, and its value must therefore be determined from time to time in the manner already explained. As an example we will suppose that on the 10th of March the following were the observations made for the purpose of a new determination of its value :—

Reading corresponding to positive contact of ⊙'s limb $= \omega = +30\ 16$, $\omega' = 0\ 46$

— — negative — — $= \omega' = -34\ 8$, $(\omega') = 5\ 12$

Quantity opposite (ω) in the table $= -25''.7$ $\omega + \omega' = -3\ 52$

— — (ω') — $-28''.6$ Half $= -1\ 56$

$-54''.3$ ... ... $-27''.2$

$\varepsilon = -2\ 23''.2$

and this new value of ε must now be applied to all angles alike, the second correction being taken from the table as before.

When the sun is observed for the purpose of determining the values of the constants, the image should be darkened by a shade placed before the eye-piece of the telescope.

The value of ε will in most cases be more or less affected by the interposition of shades before the index-glass, or behind the horizon-glass. The corrections due to each particular shade should therefore be determined, in order that in the event of our employing them for the purpose of darkening the image of the sun or moon in the course of ordinary observation, we may be prepared to apply the proper constant in the correction of the angle. This is done by observing, first, the contact of the images of the sun's limb with a shade before the eye-piece of the telescope only. The same contact being then observed with as many different combinations of the other shades as their number amounts to, we shall be furnished with as many simple equations, from which the several corrections may be determined.

A traveller on land treating the sextant in the manner above described ought very readily to obtain his latitude to the nearest second of arc: and if the results of his lunar distances be subsequently corrected for the errors in the tabular elements of the moon's place, his longitudes will probably be in most instances much within ten seconds of time from the truth. And as regards lunar observations at sea, the results must of course be materially affected by the correction of the observed angles to an extent exceeding in general the amount of probable error arising, even under unfavourable circumstances, from the difficulties attending the operation, and from deficiency of power in the instrument.

On the Value of the Constant of Refraction, as determined from Zenith-Distance Observations of Stars near the North and South Horizon, made at the Royal Observatory, Greenwich, in the years from 1836 *to* 1854. By the Rev. Robert Main, M.A.

The object of this paper is stated by the author to be the determination of the degree of accuracy with which Bessel's Refraction Tables, given in the *Tabulæ Regiomontanæ*, represent the star-observations made at Greenwich. Those tables, as is well known,

are mainly derived from the *Fundamenta*, the only change of importance being the increase of the mean refractions as far as 85° zenith distance in the proportion of 1 : 1·003282, and in the substitution of values for the mean refractions of stars below that limit, empirically derived from observation.

This break of continuity in the tables rendered it necessary to reduce all the errors ultimately to errors of the tables given in the *Fundamenta*, and to deduce the correction which it would be necessary to apply to the mean refractions given in that work.

The author enters into a discussion of the method which it would be necessary to adopt in the investigation, if the errors were ultimately found to be of sufficient magnitude to affect sensibly the places of the stars by which the latitude of the Observatory has been determined, which is fortunately proved not to be the case in the use of the refractions of the *Tabulæ*.

With regard to the materials for the investigation, it was first necessary to extract from the Greenwich Twelve Year-Catalogue, and the subsequent Star Catalogues, all the southern stars whose meridian-zenith distances at Greenwich are greater than 70°, and all the circumpolars of greater than 70° zenith-distance at their transit beneath the pole.

In the treatment of the north stars, the mean north polar distances derived from the individual observations are compared with those given in the Greenwich Catalogues reduced to the proper epoch by the annual variations given in the British Association Catalogue, the stars passing the meridian so near the zenith at the upper transit as to make the deduced places given in the Greenwich Catalogue independent of moderate errors in the refraction-tables.

With regard to the southern stars, only such were available as could be compared by means of observations made at some southern observatory near whose zenith they pass the meridian. One list of stars affording such comparison is that given in a paper by the late Professor Henderson, and printed in Vol. X. of the *Memoirs* of this Society. Only fourteen stars, however, were furnished by this catalogue which could be compared with the Greenwich Observations. Other stars for comparison were furnished from Mr. Maclear's observations of zenith-distance made with Bradley's sector at the Cape Observatory, in connexion with the triangulation. These zenith-distances, when reduced to mean north polar distances by the application of Henderson's colatitude, furnished thirty-three additional stars available for the investigation.

The author then points out the circumstances in Bessel's refraction-theory, which rendered it necessary to arrange in order of temperature the individual errors of refraction for all such stars as were observed with sufficient frequency and under different atmospheric circumstances, to discover whether any law of error were observable dependent upon temperature. The arrangement shows pretty clearly that there is no sensible error due to this element.

The remaining tables in the memoir are designed to show the errors of mean refraction of the *Tabulæ*, and the arrangement is therefore according to the order of the zenith-distances of the stars. All the errors of mean refraction of the *Tabulæ* are reduced to errors of the *Fundamenta* by comparison of the errors of the two sets of tables, and the errors of the *Fundamenta* are then grouped for convenient intervals of zenith-distance, and the results derived from the three lists of stars are finally combined.

The conclusions derived from the whole investigation, with regard to errors of mean refraction, are the following :—

1. As far as 82° zenith-distance the mean refractions of the *Tabulæ* are very nearly correct, and no corrections could be safely applied.

2. From 82° to 85° zenith-distance the logarithms of the refractions of the *Tabulæ* require diminishing by 0·00100.

3. From 85° to the horizon it seems expedient to give up the use of the mean refractions in Bessel's Supplementary Tables given in the *Tabulæ*, and to use those of the *Fundamenta*, diminishing the logarithm by 0·00066.

A projection of the star *Spica Virginis* on the moon's disk was witnessed on the 12th of March by C. R. Chalmers, Esq., at Barrie, Simcoe County, Canada West. His note of the occurrence runs thus: "The sky was cloudless, and I watched the star up to the bright edge. I then expected to lose sight of it, but it continued to advance on the face of the moon until I could distinctly see the limb *outside* the star. *Of this I am quite positive.* I counted several seconds from the first contact till the disappearance of the star, which was instantaneous. The star had a curious planetary appearance, which was also remarked by a friend at Toronto with a $4\frac{1}{4}$-inch refractor. The telescope I used is a 42-inch, by G. Dollond, of $2\frac{1}{4}$ inches aperture. Power 60." Mr. Chalmers adds that the superiority of the climate of Canada over that of England is very marked, a 3-inch aperture in Canada doing the work of a 4-inch in England.

Experiences with a Free-Revolver Stand for a Telescope at Sea, during a Voyage to Teneriffe in the Summer of 1856. By Professor C. Piazzi Smyth, F.R.S.E., Astronomer Royal for Scotland.

(*Continued from the December Number.*)

"The opportunity of making these experiments was afforded by the voyage that formed part of the astronomical expedition to Teneriffe last summer, and the vessel in which they were made

was the yacht Titania, placed at my disposal for this purpose by the princely liberality of Robert Stephenson, Esq. M.P.

"The first point to get clear ideas upon was the amount as well as the character of the angular disturbances that the vessel underwent; to which end continual appeal was made to the Naval Clinometer, previously described. (See page 38.) The disturbances were at once found to be larger in angular amount, and quicker as to time, than had been expected. The results, therefore, of the new instrument were frequently checked by direct measurement on deck by vision and ordinary angular instruments, and were invariably so well confirmed in all their most characteristic features, that full confidence was felt in the clinometer; and it was found especially useful at those times, as at night, when the direct method was not available.

"A table of observations from June 26th to July 7th is subjoined, and represents the voyage from the Channel to the African coast; and from it we gather that the rolls of the yacht varied in number between 16 and 33 per minute, and in mean angular value from 3° to 20°; the pitches of the vessel being at the same time almost equal in number, but only of about one-fifth the angular amount of the rolls.

"Examining the table further, we find that in a calm outside the Channel the rolls were 21 per minute, of 3° each; that on a gale growing up, and having its swell unmixed by others, the number of rolls was lowered to 17 per minute, but their angular extent increased to 20°, returning again to its former characteristics, when after several days the wind died away to the west of the Portuguese coast. In the broken squally weather before making the trades, and in a confessedly cross sea, where two or more swells met, the number of rolls rose as high as 33 per minute with an average extent of 8°; while when the N.E. trade was once fairly entered, and its own long regular swell ruled supreme along the surface of the water, the number went down to 19 per minute, with an angular extent of about 10°. Day after day as we sailed in the trades, the wind, while it kept one invariable direction, constantly increased in velocity; and so did the rolls, preserving nearly the same number per minute, continually increase in angular magnitude until they had reached to above 20°. How much more they would have grown to it might have been interesting to have ascertained, but we had then, on July the 8th, arrived at the end of our voyage—the island of Teneriffe, situated in the midst of the brunt of the trade wind.

"Something more, however, deserves to be considered with regard to the rolls, viz., the angular magnitude of each roll, as distinguished from the quantities already given, which are the average of a large number.

"Thus, on July 6th, the following are the angular values, in degrees, of as many rolls observed during two minutes:—12, 10, 8, 6, 4, 10, 20, 16, 17, 21, 20, 19, 22, 14, 11, 18, 19, 13, 17, 10, 14, 13, 24, 31, 29, 23, 13, 21, 10, 17, 12, 12, 14.

TABLE.

Date.	Latitude N.	Longitude W.	Wind.		Character of Sea.	Rolls of Yacht.		Angular Rolling in one Minute	Pitches of Yacht.		Rolls of Gimbal-table in Main Cabin.		Rolling of Gimbal-table in one Minute
			Velocity in Miles per hour.	Direction.		Number per Minute.	Angular Extent.		Number per Minute.	Angular Extent.	Number per Minute.	Angular Extent.	
1856.	°	°					°	°		°		°	
June 26	50	4	0	0	Calm.	21	3	63	21	1	..	..	..
27	49	4	3	E.	Swell growing.	·17	7	119	16	1	..	..	..
28	48	6	13	E.	Waves high.	17	12	204	16	1	45	8	360
29	46	9	15	N.E.	Waves running high.	17	20	340	19	2	43	7	301
July 1	43	11	2	S.	Broken sea.	20	9	180	21	3	40	..	280
2	42	11	2	N.	Glassy swell.	*(19	6	114	20	2)	..	..	..
..	..	..	..	..	..	20	4	80	20	2	..	..	..
3	41	11	5	N.W.	Smooth water.	18	4	72	..	..	..	..	..
At 4 P.M.	..	..	8	N.W.	Wind rising and cross sea.	33	8	264	22	3	..	..	..
At 6 P.M.	..	..	8	N.W.	Two swells interfering.	25	10	250	27	4	46	4	184
4	39	11	5	N.W.	..	21	6	126	22	2	..	..	..
5	37	12	8	N.N.E.	Rolls regular.	18	6	108	18	2	28	4	112
3 h.	..	..	10	N.N.E.	..	19	10	190	..	..	..	..	..
6 h.	..	..	12	N.N.E.	..	17	15	255	..	..	..	..	..
6	34	13	13	N.N.E.	..	19	16	304	18	1	27	8	216
7	31	15	15	N.E.	..	16	20	320	16	4	..	..	..

* These observations were by direct measurement on deck.

"And, again, on July the 7th, the following series was obtained in 8 consecutive minutes:—

°	°	°	°	°	°	°	°
22	22	20	9	25	13	20	28
21	17	17	9	21	16	22	31
11	17	16	10	16	18	24	27
8	19	25	7	11	17	21	21
17	11	26	9	13	21	13	22
23	18	20	13	19	20	21	19
16	20	17	15	21	19	26	10
23	10	14	13	23	16	21	9
16	13	9	9	29	12	17	19
21	15	5	10	29	11	15	27
18	17	4	16	26	12	13	29
18	15	8	18	24	11	12	22
22	11	14	16	18	10	13	13
22	12	14	13	...	...	12	11
26	15	...	12	16	16	13	15
27	...	...	15	16	17	...	...
18	...	...	23	15	...	20	18

"These numbers, while vividly demonstrating the amount of disturbance of the yacht's deck, also indicate the very compound nature of the rolling of a vessel at sea; for, through the individual undulations, there run evidently others of a longer period, and through those others still longer. Indeed, I was never able to get any regularly recurring series of numbers; and after the passage of any given maxima and minima, there were sure to appear in the course of time others of yet higher order and greater intensity. On one occasion, after long watching, I caught a roll of 40°; and this did, while rolls of 31° did not, set things generally rolling and tumbling about in the cabin. As this species of actual and social disturbance below deck only occurred three or four times in the day, we may assume that there are amongst the waves of the sea undulations having a period of several hours, and with their crests from 30 to 40 miles apart.

"Such a result shows that no practical increase in the size of ships will altogether do away with their rolling at sea—that rolling which tends so to the discomfiture of the passengers, and the impossibility of taking telescopic observations. Neither can the old-fashioned plan of swinging tables avail anything. This was shown from principle in the paper of last year, and was found in practice on this voyage; for, as may be seen in the tabular representation of the observations, measures were made of the rolling of the dinner-tables on board the yacht; the tables being hung on pivots with a heavy weight below. They answered their purpose famously as dinner-tables for rough sea weather, for the plates and dishes kept their places marvellously. But when tested by

the clinometer, or by the sun, they were found to be continually oscillating, through a less angle certainly than the yacht was rolling to, but so much more quickly, that the angular amount, multiplied by the number of vibrations, generally gave a larger total quantity of displacement in a minute for the swinging-table than for the yacht. In the little yacht the motions were doubtless much more excessive than in the larger class of ships now employed in long voyages; but if so, the occasion was all the more proper for testing the 'Free Revolver Stand,' as a means of eliminating from an astronomical instrument both the rolls and the pitches of a vessel.

"One of these instruments, on the principle already described, was on board, and was set in action on the 3d of July.

"The telescope mounted was a small one, magnifying 7 times; and having an eye-hole of one-eighth of an inch. The revolver was 1 foot in diameter, weighed 10 lbs., and was driven by two sets of wheel-work acting on either side of the spindle. The apparatus was arranged inside a sort of observatory box, into which the observer could insert his head and two hands, while openings for observations could also be made. The only convenient place on the deck for erecting the instrument was near the stern, where was the maximum of the up and down movement, and the look-out was over the quarter, with the full effect of the rolling; all this, however, was well for testing the new principle.

"The sailors were called up to work the driving-wheels, and when they had got up about 80 revolutions per second in the revolver, the wheels were withdrawn, the gimbal rings unclamped, and I had the satisfaction, for the first time that any one had had, of looking at sea through a telescope steadied by the same mechanical effort as that which preserves the constancy of the earth's axis in space.

"The following practical points were soon ascertained: first, that in spite of the egregious rolling of the yacht, which must be partaken of by the observer, but is happily not partaken of by a telescope mounted as ours, there is no difficulty in keeping the eye *en rapport* with the eye-piece, although in the present case the size of the eye-hole is extremely small; second, that the position of the platform of the telescope can be adjusted with great nicety in any direction as respects deviation from the horizontal plane, by simply pressing on one of the gimbal rings, in a direction 90° removed from that in which it is desired that motion should take place; and, third, that the telescope can be adjusted in azimuth or altitude by rack and pinion, without sensible derangement to the position of the platform.

"Having performed these adjustments, and brought the horizon of the sea into the field of view, I was delighted to find it remain there, absolutely uninfluenced by the rolling and pitching of the yacht; nay, it even remained bisected on the wire sufficiently long for the captain, the first and second mates, and several of the sailors, to look in and bear witness of the fact. They saw

this consummation long desired at sea, and they took kindly to the instrument, though it was an innovation on nautical practice.

"In order to perfect the balance of some parts of the machine, which had left its maker's shop rather unfinished, I kept the sailors for several days working the driving-wheels while I was experimenting; they laboured at them with enthusiasm, indeed, rather too much so, for one unfortunate evening, when the instrument was so nearly perfect that I hoped in the course of the night to essay the grand nautical problem of observing an eclipse of one of *Jupiter's* satellites, the sailors, impatient of the difficulty of getting up immediately the full speed, clapped on a rope to the handle of the driving-wheel, and pulled away in such style, that they twisted the strong steel driving-axle in two, and were themselves laid flat along the deck.

"The practical sufficiency, however, of the single-wheel revolver stand, for correcting the rolling and pitching of a ship at sea, had been abundantly proved. And more than this, the azimuthal deviations of the yacht, which had been previously neglected as comparatively trifling, so long as rolling and pitching existed, were now found, when these were eliminated, and yawings left as the sole residual, to be absolutely so large, and so annoying to telescopic vision, as imperatively to demand attention and correction by the same revolver method also. On looking into the telescope, for instance, on the above-described stand, no change of plane from the horizon of the sea could be discovered; but any point in that plane, as a distant ship, was oscillating backwards and forwards in the horizontal direction twenty times in a minute; this being the effect of the azimuthal changes of the position of the yacht not having been eliminated as had been the rolling and the pitching.

"The application of a second revolver to the apparatus which was employed on board, to enable it to eliminate all the angular disturbances of the yacht would be easy, as indeed I described in my paper of last year, and such an addition should be a necessary preliminary to any further trials at sea."

Dr. William Stroud, in two letters to Dr. Lee, draws attention to two lunar eclipses which he imagines to be important as helping "to dispel some doubts and difficulties which still beset the chronology of the Christian era." The first of these he supposes to have happened at the autumnal equinox of the year B.C. 5, and the latter in the year A.D. 30, at the Paschal full moon corresponding to the time of the Crucifixion of our Saviour.

With regard to the first of these, it appears that there were two lunar eclipses in each of the years B.C. 4 and B.C. 5, one at the vernal and the other at the autumnal equinox; and they are

therefore of little use in fixing, in connexion with the well-known passage of Josephus, the date of Herod's last illness.

With regard to the eclipse of A.D. 30, its connexion with the date of the Crucifixion appears to rest only on the figurative expressions quoted by St. Peter from the prophet Joel: "The sun shall be turned into darkness and the moon into blood before . . ." As the purely astronomical portion of such speculations may rightly be considered to fall within the province of this Society, perhaps some Fellow possessing the leisure and requisite means, will oblige Dr. Stroud by undertaking an accurate computation of the eclipses in the above-mentioned years, with the data of the best modern tables.

Abstract of a Memoir in Vol. IX., Part IV. of the Cambridge Philosophical Society's Transactions, entitled, 'On the External Temperature of the Earth, and the other Planets of the Solar System.' By W. Hopkins, Esq. F.R.S. and V.P. C.P.S.

The author of this paper states in the outset that he was led into the researches therein contained in consequence of the interest excited by recent speculations involving the conditions of existence of organised beings,—conditions comprising heat, light, moisture, &c., of which he proposes to examine the one of temperature. He remarks that we have not the means of determining the actual superficial temperature of any planet besides our own, but that we know it must mainly depend (1) on the temperature of planetary space, (2) on the direct heat which the nearer planets receive from the Sun, and (3) from the modifications which result from their atmospheres, the positions of their axes of rotation, and the conductivity and specific heat of the substances forming their outer crusts,—modifications which may have a far greater influence than has been generally supposed.

He commences by general remarks and illustrations on the various modes by which heat may be transmitted, by complete or partial radiation, by conduction, or by convection, applying them, in the first place, to the Earth, and considering separately the mean temperature and the annual and diurnal variations.

"It is almost entirely by direct radiation that the solar heat reaches the Earth's surface, when the atmosphere is pure. . . . In the transference of the heat back again, all the other modes of transmission must be more or less effective, though we are altogether ignorant of their relative degrees of efficiency. It is, however, sufficient for us to know that none of them can be effective unless the temperature of the atmosphere decrease continually as we ascend from its lower to its upper regions. . . . . It will be my object to examine the data we possess for determining numerically what would be the effect of an *increase* or *diminution* of our atmosphere on terrestrial temperature, and also what is the actual effect

of the Sun's heat on that temperature. We shall then be able to judge what may be the probable influence of similar causes on the temperatures of the other planets."

The author avails himself extensively of the previous researches of Poisson, presenting the results, however, in a simpler form. He first confirms, by several independent routes of inquiry, Poisson's resulting value of the temperature of the constituent particles of the atmosphere at its upper limit,

$$-273^\circ \text{ Centigrade},$$

remarking that this very low temperature is not to be confounded with that of surrounding space, but is to be understood to be that of the air at a point where its elasticity is lost, and it is reduced to the state of a fluid.

As his data for obtaining the decrement of temperature for a unit of height, he discusses the observations of Mr. Welsh in his four balloon ascents from Kew, in which were found severally,—

1852.	Height reached.	Decrement per 1000 Feet.
Aug. 17	19510 feet	3°·434 (F.)
,, 26	19100 ,,	3·440
Oct. 21	12640 ,,	3·431
Nov. 10	22930 ,,	3·205

Mr. Hopkins passes over the third of these results as obtained by a considerably less ascent, and attributes the discrepancy of the fourth to a difference of 19° (F.) in the temperature of the air at sea-level on Nov. 10. He remarks that such observations would alone enable us to form some estimate of the effect of an assigned increase or decrease in the atmosphere; an increase or decrease by a quantity corresponding to a space of 1000 feet at the surface, for example, sufficing to raise or lower the superficial temperature by 3° (F.), and proportionately for greater values.

As this is the most striking point in the memoir before us, we pass over the author's conclusions respecting distribution of temperature and periodic variations, to give his summary of results obtained with reference to the Earth, calling especial attention to his paragraph (3).

"(1) I have endeavoured to explain, as fully as possible, the manner in which the atmosphere produces its influence on the temperature of the Earth's surface; and to show that the temperature of the constituent particles of the atmosphere at its upper limit must be exceedingly low.

"(2) If as much atmosphere were removed from the Earth as now forms an inferior stratum of about 525 feet in thickness, the mean annual temperature of each point on the Earth's surface would be diminished by 1° (C) . . . . . If the thickness of the stratum removed were greater, the diminution of temperature would be greater in the same ratio . . . . An increase would produce an exactly similar, but opposite effect.

"(3) After explaining Poisson's method of treating the problem of terrestrial temperature, and his mode of estimating the direct effect of the solar heat radiating to the Earth. . . . I have shown that the *whole effect* of the solar heat on the mean value of this superficial temperature is equal to nearly twice the immediate effect, which was the object of Poisson's calculation, except in cases in which there may be a considerable horizontal transference of heat from local causes.

"(4) Assuming that the temperature of every part of the Earth's surface would be the same in the entire absence of the Sun's influence, I have estimated that temperature at $-39°{\cdot}5$ (C). This must not be confounded with the temperature of that portion of stellar space in which the solar system now exists, a temperature which we have not the means of determining.

"(5) I have also shown that *annual inequalities* in the temperature of the lower stratum of the atmosphere are nearly equal in amount to those in the Earth itself at its surface, with exceptions similar to those mentioned in (3)."

The author next shows how that, if the Earth were placed at the distance of *Jupiter*, where the intensity of solar radiation is diminished in the ratio of 1 to 27 nearly, the mean annual temperature at the Equator would be $-36°{\cdot}9$ (C) and at the Pole little more than $-39°{\cdot}5$ (C), leaving out of consideration the effect which this reduction of temperature would have on the height, density, and transmissive quality of the atmosphere. The annual inequality at any latitude μ would be about

$$\pm\, 0°{\cdot}6 \sin \mu \quad \text{(C)}.$$

or sensibly negligible; and in passing from the Equator to the Poles the whole change of temperature would never exceed about $3°$ (C). The addition of 35,000 or 40,000 feet to the thickness of the Earth's atmosphere, if revolving in *Jupiter's* orbit, would unquestionably elevate her equatorial temperature to about that of our temperate zone at present. The principal difference between the Earth and *Jupiter* at this distance would arise from the greater density of the atmosphere about *Jupiter*, consequent on the greater mass; but the observations of Mr. Welsh, continued to a point at which the density of the atmosphere observed was reduced to less than one-half, lead to the conclusion that the transmissive power is nearly independent of the density, and that there would be no material difference in the rate at which the temperature would decrease in receding from the surface. "There seems reason to believe that *Jupiter* has an atmosphere much greater than that of the Earth, and it may be of such a thickness as entirely to counterbalance the defect of heat derived from the Sun by direct radiation. His climate must, however, differ from that of the planets nearer to the Sun, in the comparative absence of periodical variations. . . .

"The cases of the planets more remote than *Jupiter* are still more simple than that of *Jupiter* himself, since solar radiation can have no sensible effect whatever upon them. If the Earth were

placed in the position of any one of these planets, and equilibrium of temperatures due to internal and external causes respectively were so far established as it is under existing conditions, her superficial temperature would, according to our previous calculations, be about $-39°{\cdot}5$ (C); but if her atmosphere were increased to the requisite amount, this temperature might be increased, as we have seen, in any proposed degree, and so it must be with these remote planets themselves. Their superficial temperatures must be entirely uniform independently of variations due to local or temporary causes, and must depend on the quantity of atmosphere by which they may be respectively surrounded."

Treating next of the planet *Mars*, whose circumstances do not greater differ from those of the Earth, Mr. Hopkins calculates that the mean temperature of the Earth with her present atmosphere, moving in the orbit of *Mars*, would be at the Equator $-10°{\cdot}7$ (C), and at the Pole $-34°{\cdot}3$ (C); an additional depth of atmosphere to the extent of 15,000 or 20,000 feet would however suffice to raise the Equatorial temperature to about $15°{\cdot}5$ (C) or 60° (F).

For the Earth, moving in the orbit of *Venus*, with her present atmosphere and inclination of axis, the author similarly finds as the mean temperature of the Equator 95° (C), and of the Pole $16°{\cdot}5$ (C), both of which would doubtless be much modified by lateral transference. The maximum annual inequality at the poles is estimated at about $\pm$ 32° (C), but the inclination of axis usually adopted as existing for *Venus* herself would cause her seasons to be totally different from those of the Earth. Passing over the conclusions on this part of the subject, it is inferred, that a deduction of a superficial stratum of 25,000 feet of atmosphere would reduce the temperature of the equinoxial regions of *Venus* to that of the temperate regions of the Earth, that of her polar regions exceeding our tropical temperature by 12° or 13° (C). The direct heat of sunshine during the day would be about double that of our own. Certain further and allowable assumptions might materially modify these results, and permit the conclusion that large portions of the surface of *Venus* might be habitable by beings little better calculated than the human race to bear the extremities of heat and cold.

The author treats also of the case of our Moon, assuming her to be devoid of atmosphere, and with this application of his formulæ closes the subject.

Extract from a Letter received by the Astronomer Royal from Mr. Otto Struve, dated April 7.

"Has it been remarked by English astronomers that, this spring, the breadth of the obscure ring of *Saturn* was, on the following ansa, double (or at least one and six-tenths) of that on the preceding ansa? This feature was so striking on March 20, that it could be seen even by unpractised observers on the first glance."

Lord Wrottesley has favoured the Society with a communication of some observations of the appearance of the planet *Saturn*, made by his assistant, Mr. Frederic Morton, in the months of January and February last. Powers ranging from 320 to 600 were applied to the 11-feet Equatorial of $7\frac{3}{4}$-inches aperture.

On Jan. 20, the fine mark on the outer ring (A) was seen defined with great sharpness, and again by glimpses on the 29th.

The dusky ring (C) was generally observed to be bounded by a sharply-defined inner edge, with a black sky between it and the ball of the planet. On these occasions the common boundary between (C) and the middle ring (B) was never well marked, a phenomenon which Mr. Morton attributes to the apparent overlapping of the outer edge of the dusky ring on the inner edge of the middle ring. The shading of the inner portion of the ring (B) was seen to extend from the ring (C) to the middle of (B). Other observers have, however, noticed a more luminous streak between the shading on (B) and the outer edge of the dusky ring.

Lieut. Tennant has forwarded a printed slip containing further data relating to the annular eclipse of the Sun on the 18th of September next. As his table of limiting lines has been already given in page 18, and local phases must be principally serviceable to residents in India, it appears sufficient to state that this additional information may be obtained by reference to the *Roorkee Almanac* for the N.W. Provinces.

In consequence of the miscarriage of a letter, the death of our respected associate, Prof. Colla, late Director of the Observatory at Parma, has not hitherto been announced. Professor Pigorini, in a letter to Mr. Hind, informs the Society that he has been intrusted provisionally with the direction, until the Government makes some permanent arrangement.

A reprint has been made (in 8vo.) of Professor Hansen's Supplement to his Solar Tables, a paper which appeared in the last number. Prof. Hansen informs the Astronomer Royal that it is his intention to send the two Supplementary Tables, with the necessary explanation, to Copenhagen, to be printed in 4to. to correspond with the volume. It may, however, be convenient to some of our members to obtain copies of the communication to the *Monthly Notices*, for temporary use. They may be had by possessors of the Solar Tables on application to the Assistant Secretary at the apartments of the Society.

Considerable difficulty is anticipated in the re-discovery of the planet *Daphne*, detected on the 22d of May last year by M. Hermann Goldschmidt, when already far past opposition. The planet was estimated at the first little to exceed the 12th magnitude, and before the 20th of June it was found impossible to procure another observation even with the Berlin refractor.

It has been thought desirable to portion out the region of the heavens in which it may be expected to appear during the ensuing opposition, and a notice to that effect has just been put forth in the *Astron. Nach.*, with the intimation that Dr. Luther will especially undertake to search during August, September, and October, between 0^h and 1^h R.A.; Dr. Bruhns, between $23^h\ 0^m$ and $23^h\ 30^m$; M. Chacornac, between $23^h\ 30^m$ and $24^h\ 0^m$; and M. Goldschmidt, between 22^h and 23^h, as well as between $23^h\ 30^m$ and $24^h\ 0^m$. M. Pape of Altona will search between $22^h\ 30^m$ and $23^h\ 0^m$; and will shortly prepare an Ephemeris to guide observers in the adoption of limits within which to confine their attention. The co-operation of other observers in the examination, particularly, of hours 22 and 23, is solicited by Dr. Peters. The following Elements have been computed by Professor Valz of Marseilles:—

Daphne.

Epoch 1856. May 31·429.*

		°	′	″
M	=	330	19	54
π	=	231	5	48
Ω	=	179	29	10
i	=	15	0	9
φ	=	12	26	12
a	=	2·4899		
μ	=	903″·10		

* Probably mean Marseilles time.

An account of his lecture on the 8th of April, on the Parallax of the Sun, which the Astronomer Royal has kindly promised to send, is unavoidably postponed to another Number, from the pressure of other astronomical business, and the necessity of waiting the preparation of a copper-plate containing the diagrams in illustration.

ERRATA.

Vol. XIII. page 149, Position of *Oberon* on Nov. 2, *for* 206° 40′, *read* 196° 40′.

Vol. XVI. page 221, line 9 from the bottom, *for* immersion, *read* emersion.

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London :—Printed by G. Barclay, Castle St. Leicester Sq. and Published at the Apartments of the Society, May 7, 1857.